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PETROCHEMISTRY AND RADIOACTIVITY OF GABAL ABU AQARIB ALKALI FELDSPAR GRANITE, CENTERAL EASTERN DESERT, EGYPT

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ABSTRACT

The present work deals with geology, geochemistry, and radiometery of Gabal Abu Aqarib Alkali Granite, Centeral Eastern Desert, Egypt. Gabal Abu Aqarib about 136 km2, and represents a part of the late Precambrian Arabian Nubian Shield. It is of alkali feldspar granite composition and may be considered epeirorogenic uplifts granitoids.

Geochemically, the granite rocks of G. Abu Aqarib were originated from a metaluminous calc-alkaline magmas that developed in volcanic arc post orogenic tectonic setting.

The studied granite rocks of G. Abu Aqarib area were generated at depth of about 9-20 km equivalent to 4-6 Kb and temperature ranging from 760°c to 840°c with multi-processes of both assimilation and fractional crystallization involving plagioclase, hornblende and Fe-Ti oxides from a partial melted lithospheric magma.

The U and Th contents in the studied area are associated with hematitization and silicification. Also, the radioactivity are controlled by the presence of higher content of zircon as accessory minerals and iron oxides while iron oxide and hydroxides are know to absorb U from circulating fluids.

INTRODUCTION

The Egyptian granitoids have been classified by many workers; e.g.El Ramly and Akaad(1960),El Shazly 1964; Hashad (1980),El-Gaby&Habib (1982), Hussein *et.al.*(1982) and Hassan and Hashad(1990). El-Gaby&Habib (1982), classified the granite into two groups: a) Syn-to post orogenic calc-alkaline series,and b) Younger, post-tectonic, alkaline to peralkaline granite series. Hussein et.al.(1982)defined three groups of granites: G1 type refer to subduction-related syn-orogenic granites,G2 type comprises late to post orogenic granites formed by partial melting of the lower crust and G3 type including post-orogenic granites produced by melting of pre-existing crustal rocks.

According to Hashad (1980);Hassan and Hashad(1990),the Egyptian granitoids represent two distinct magmatic episodes.The oldest magmatic episode (older granites)shows calc-alkaline, I-type affinity and subduction related(Stem et.al.1984). This episode is syn-tectonic and have an age 1000-850Ma.The youngest episode comprises essentially late-post tectonic granites of about 620-530Ma.These rocks represent anorogenic magmatic pulse related to NW-SE to N-S rifting system (Stem *et.al.* 1984). The specific timing of emplacement of the alkali granites with respect to the Pan-African orogeny includes two views .Some authors believe that the alkali granites are post-collision granites generated at the end of the Pan-African orogeny (Bentor,1985;Stem&Hedge1985).Others believe that the alkali granites were generated in intraplate environment after formation a new continental crust of the Arabian-Nubian Shield (Hussein *et. al.*,1982 and El-Gaby *et. al.*, 1988) with age range between 600-475Ma.(Abdel Rahman and Doig 1987).

The present study deals with the geology , geochemistry, and radiometery of G. Abu Aqarib alkali-feldspar granite,which lies between latitudes 26° 23' - 26° 27' N and longitudes 33° 45' – 33° 47' E and covers about 136 km^2 (Fig.1) .

GEOLOGIC SETTING

Generally G Abu Aqarib area represents a part from the centeral segment of the Egyptian outcrops of the late Precambrian Arabian Nubian Shield.It includes serpentinite and talc

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carbonate rocks, which emplaced along a major shear zone and thrusted over the surrounding island arc metavolcanics (Khalaf *et al* 2000) .The island arc metavolcanics show tectonic contacts with the Dokhan volcanics.They are unconformably overlain by the Hammamat sediments and intruded by G Abu .Aqarib alkali-feldspar granite .

Serpentinite and talc carbonate rocks:

The main outcrop of serpentinite and talc carbonate rocks are lies along wadi Kab El-Rushud at the southwestern side of G Abu .Aqarib mass.They crop out as elongated lense thrust over the island arc metavolcanics (Fig.2). The serpentinite and talc carbonate rocks are of yellowish, greyish, greenish black colours, and characterized by NW shear zone affecting talc carbonate and brecciated serpentinite .

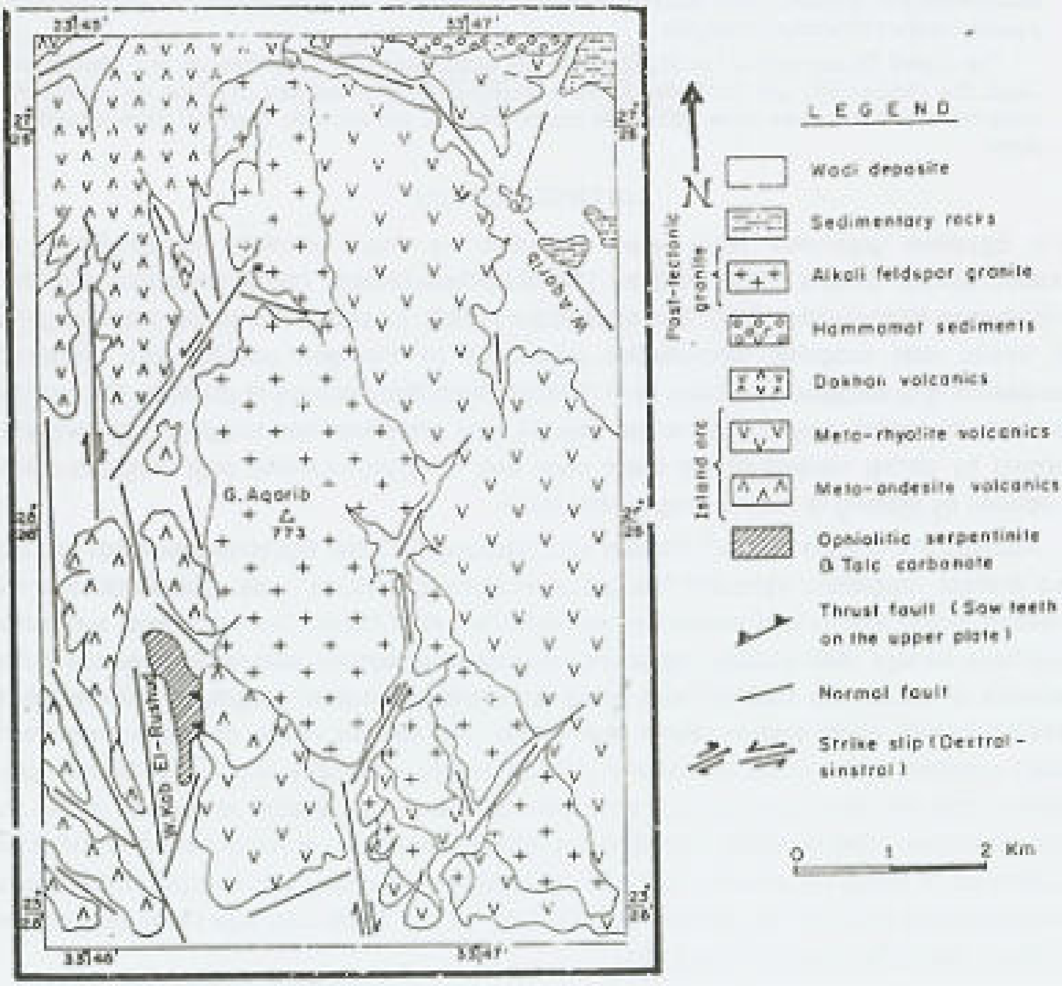

Fig. 1 : Geologic map of G. Aqarib area
(modified after Khalaf et. al. 2000)

Island arc metavolcanics:

a)Meta-andesite:

Meta-andesites are exposed mainly at the southwestern part of the mapped area along Wadi Kab El-Rushud, forming a moderate reliefs.They are slightly foliated , fine to medium grained of greenish grey colour and composed mainly of plagioclase (phenocrysts),quartz(subordinate amounts) and mafic minerals(hornblende-amphibole) .

b)Meta rhyolites:

Meta rhyolite are commonly crop out east of G. Abu Aqarib alkali-feldspar granite pluton ,along Wadi Aqarib.They are slightly foliated and form NW-SE moderate relief. Meta rhyolites are fine to medium grained,redish brown in colour and composed mainly of plagioclase (phenocrysts),alkali-feldspar,quartz and mafic minerals (biotite-chlorite) . The island arc metavolcanics show tectonic contacts with the Dokhan Volcanics , overlain unconformably by the Hammamat sediments and intruded by G. Abu Aqarib alkali-feldspar granite (Fig.3) .

Dokhan Volcanics:

The Dokhan volcanics are represented in the northwestern corner of the mapped area. They show tectonic contacts with the island arc metavolcanics, unconformably overlain by the Hammamat sediments and intruded by G. Abu Aqarib alkali-feldspar granite (Fig 4). Dokhan volcanics are situated in the final stage of subduction (Ressetar & Monrad, 1983).

Hammamat sediments:

The Hammamat sediments were formed by erosion of adjacent uplifts and rapid deposition in isolated "intermountain" basins(Grothus et.al. 1979).In the mapped area the Dokhan volcanics outcrop in the northern side of Wadi Aqarib .They are comprise immature and poorly sorted breccias , sandstones, siltstones and conglomerates(Khalaf et. al. 2000) .

Alkali-feldspar granite:

The alkali-feldspar granite are represented in the mapped area by G. Abu Aqarib intrusion. It is of moderat to relatively high relief, with N-S elongated form 6x2.5km (Fig.5). Exfoliation and bouldery weathering are well developed due to joints intersecting .Occasionally,the main joint sets are filled with iron oxide solutions (Figs.6&6*). G. Abu Aqarib alkali-feldspar granite intruded the serpentinite and talc carbonate rocks,island arc metavolcanics, Dokhan Volcanics and Hammamat sediments but it self cut by basic to intermediate and acidic dykes as well as quartz veins .This type of granite are heterogenous in colour,grain size and mafic contents. It is medium to coarse grained .and composed essentially of alkali-feldspar ,quartz, plagioclase, amphibole, minor biotite and iron oxides.

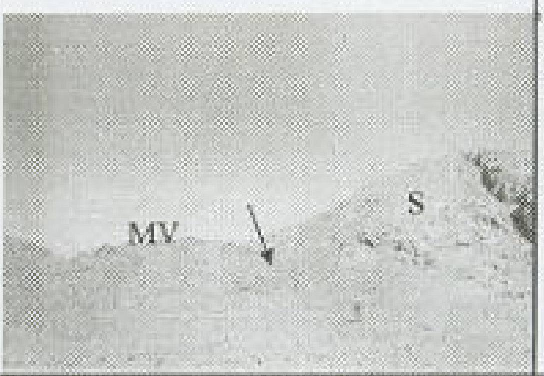

Fig. (2): Ophiolitic serpentinite-talc carbonate lense (S) thrusted over meta-andesite volcanics(MV). Looking SW.

Fig.(5): General view for G. Abu Aqarib alkali-feldspar granite

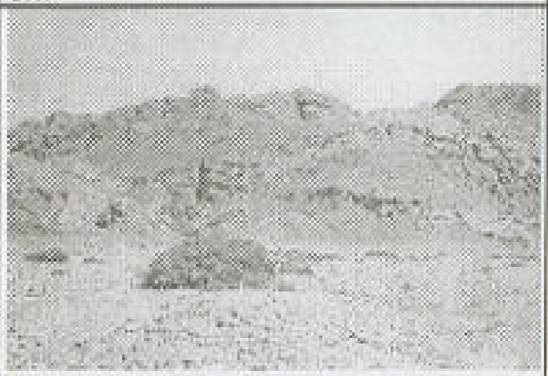

Fig.(3): G. Abu Aqarib alkali-feldspar granitic mass with meta-andesite slices. Looking SE.

Fig.(5): Close up view for iron oxide enriched flow up through the main joint sets at G. Abu Aqarib alkali-feldspar granite.

Fig.(4): Intrusive contact between G.Aqarib alkali-feldspar granite (V) and Dokhan volcanics (G). Looking NE.

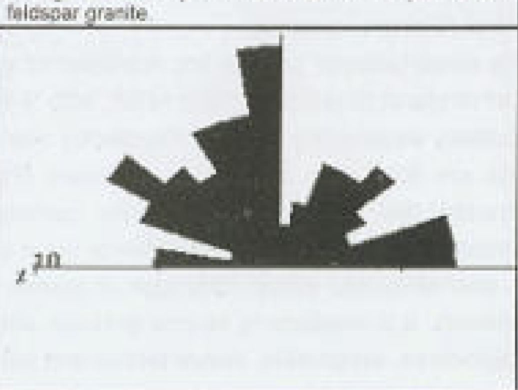

Fig (6*): Collective rose diagram for joints upon G. Abu Aqarib alkali-feldspar granite.

PETROGRAPHY

G. Abu Aqarib Alkali-feldspar granite are medium to coarse grained and characterized by hypidiomorphic granular texture and composed mainly of alkali-feldspar(orthoclase and minor microcline),quartz and subordinate plagioclase (Fig.7).The main mafic minerals are either amphibole or biotite. Accessories are represented by zircon, sphene,apatite and iron oxides (fig.8). Alkali-feldspar is abundant, which may reach 70% of the whole constituents. Orthoclase occurs as large subhedral crystals with perthitic texture. Few crystals are slightly sericitized and show poikilitic texture. Microcline occurs as subhedral crystals showing antiperthitic texture (Fig.9). Quartz occurs as anhedral coarse to fine crystals exhibiting undulose extinction. Sometimes, it is cruched into fine interstices crystals .Plagioclase occurs as subhedral prismatic crystals showing albite twinning, zoning and myrmikitic texture with variable degrees of alteration (Fig.10). It is occasionally corroded by quartz .Amphibole occurs as aggregates of fine dark brownish green fibrous . They pleochroic from dark brown to yellowish brown .Biotite occurs as greenish brown flakes (Fig.11) which is slightly to completely chloritized. It is pleochroic from yellowish to greenish brown. Zircon, sphene and apatite are enclosed in feldspar and quartz crystals (Fig.12). Iron oxides occur as fine hematitic reddish brown minutes. Some iron oxides are associated with the borders and along the cleavge planes of biotite fibours.

Modal analysis:-

Eight samples representing G. Abu Aqarib granite were subjected to modal analysis for quantitative mineralogical composition. The results of the modal analysis of the studied granite samples are given in table (1) and are plotted graphically in the QAP triangular diagram of Streckeisen (1976), (fig.13).The figure indicates that this granite is classified as alkali feldspar granite (IUGS 1973) and Streckeisen (1976). According to Maniar and Piccoli, (1989) the studied granite are located in the field which indicate that they are anorogenic granitoids. They may be considered either as rift related or epeiorogenic uplift granitoids.

Table (1): Modal analysis of Gabal Abu Aqarib Alkali feldspar granites.

	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9
Qz	28.10	27.40	28.50	26.18	29.54	29.00	27.13	30.84	31.05
Plag.	0.82	1.07	0.72	0.88	1.02	0.79	0.97	0.57	0.76
K-feld.	65.13	68.14	66.13	64.90	69.01	66.13	66.13	65.90	66.10
Mafics	5.95	3.39	4.65	8.04	1.38	5.77	5.77	2.69	2.09
Total%	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Geochemistry of Granitic Rocks

1-Variation in chemical composition

In this section, it is intended to determine the petrochemical features of granitic rocks of G. Abu Aqarib area and to solve the genetic relation of these rocks. Also, to determine the magma types and the tectonic settings under which these granitic magmas were generated. To achieve these objectives, 9 samples were chemically analyzed in the laboratory of Nuclear Material Authority (NMA) for major oxides and the trace elements Rb, Sr, Ba, Y, Zr, Nb, Cu, Zn, Ni, Co, Cr, V and Ga. The analytical results of the major oxides and trace elements are shown in Table (2). The table also shows the CIPW normative compositions and some petrochemical parameters.

The average of the differentiation index of granitic rocks of G. Abu Aqarib area are 88.14.

The differentiation index (D.I) of studied rocks are plotted against the different major and some trace elements (Fig.14). The figure show a negative correlation between Al_2O_3, CaO and, MgO with D.I. while SiO_2, Na_2O and K_2O show a positive correlation. Also the figure shows that the elements Rb and Sr have increasing trends with increasing D.I., It is also clear that the studied samples mostly show straight-line variations which may indicate Co-magmatic differentiated.

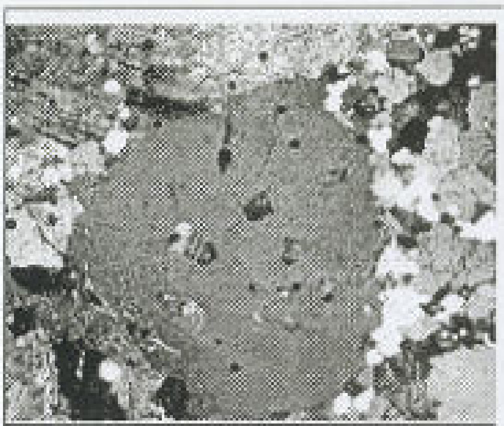

Fig.(7):-Photograph showing alkali feldspar, quartz, and plagioclase in alkali feldspar granite. X=60 C.N.

Fig (8):- Photograph showing Zircon, sphene, apatite and iron oxides in alkali feldspar granite. X=60 C.N.

Fig.(9):- Photograph showing antiperthite texture in alkali feldspar granite. X=60 C.N.

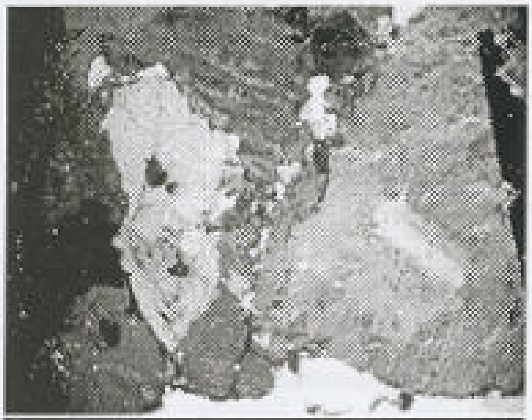

Fig.(10):- Photograph showing myrmikitic texture in alkali feldspar granite. X=60 C.N.

Fig.(11):- Photograph showing biotite inclosed in quartz in alkali feldspar granite. X=60 C.N.

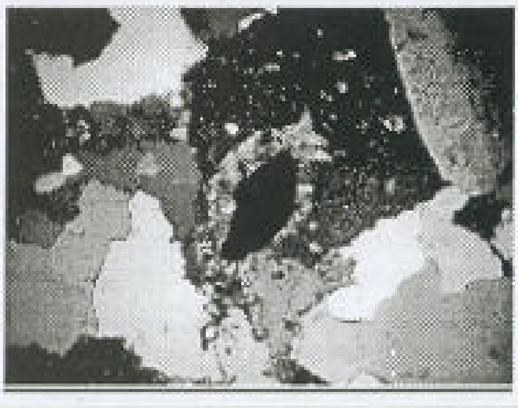

Fig.(12):- Photograph showing opaqus, zircon and sphene in alkali feldspar granite. X=60 C.N.

2- Nomenclature

We can observe the petrochemical nomenclature, the genetic classifications for the studied granite by using some variation diagrams proposed by Middlemost (1985), Le Maitre, (1989), Chappell and White,(1974), Gunther *et al.*, (1989) and Harris *et al.*, (1984) as follows.

Middlemost (1985) used the binary relation between SiO_2 and Na_2O+K_2O (wt%) to differentiate between different rock types as showing in (Fig.15). It is clear from the figure that the studied samples of G. Abu Aqarib area are lie in the granite field.

The total alkali-silica (TAS) of Le Maitre, (1989) (Fig. 16) shows that the granitoid rocks of G. Abu Aqarib area plot in the granite field.

The studied granitoids can also be classified according to their normative Ab, An, and Or contents using the following diagrams. The (Or-Ab-An) diagram of Hitannen, (1963), shown in (Fig. 17), indicates that the granitoid rocks of G. Abu Aqarib area plot in the granite field . The (Ab-An -Or) diagram of Streckeisen (1976), shown in (Fig. 18) show that the studied granitoids rocks of G. Abu Aqarib area plot in the alkali feldspar granite fields and some samples lie in the syanogranite and alkali feldspar granite fields.

Magma Types

The magma types of the present granite are investigated using major and trace elements contents, some geochemical parameters and normative compositions (Table 2).

Agpaitic index is a geochemical parameter defined as $[(Na_2O+K_2O)/Al_2O_3]$ (in molecular proportion), (Goldschmidt, 1954). The average agpaitic index of G. Abu Aqarib is about 0.82 which means that the studied granitoid rocks are miaskitic in nature.

The total alkalies of the studied samples are plotted against SiO_2 content (Irvine and Baragar, 1971) shown in (Fig. 19), where the studied samples plot in subalkaline field.

Maniar and Piccoli (1989) used the Shand index to distinguish between the peralkaline, metaluminous and peraluminous rocks as shown in (Fig. 20), where the data points of G. Abu Aqarib granite rocks plot in the metaluminous and some samples in peraluminous fields.

Bailey and McDonald (1969) and McDonald and Bailey (1973) used the ternary diagram SiO_2–Al_2O_3-(Na_2O+K_2O) shown in (Fig.21) to distinguish between the calc-alkaline, alkaline and peralkaline rocks where the data of G. Abu Aqarib granite plot in the calc– alkaline field.

Figure (22) shows AFM diagram (Irvine and Baragar, 1971) for the studied granite, where the studied samples plot in calc-alkaline field and the samples show a trend parallel to the AF side (Petro *et al.*, 1979).

Chappell and White, (1974) used the binary relation between Na_2O and K_2O to differentiate between S- and I-type granites shown in (Fig.23). The I-type granites include those which represent mantle derived rocks, while S-type granites are products of partial melting of crustal material during continental collision (Pitcher, 1983), the figure shows that the studied granitoid are POG.

Also, Harris *et al.*, (1984) used the binary diagram between Rb/Zr and SiO_2 to differentiate between S and I- types (Fig. 24). It is clear that the studied samples plot in I-type volcanic arc granites.

To summarize, the studied miaskitic granite rocks originated from metaluminous to peraluminous calc-alkaline magma types.

Table (2): Chemical analysis of major and trace elements Alkali-feldspar granite rocks of G. Abu Aqarib area:

S. No.	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9
	70.81	70.61	71.10	70.88	71.19	71.31	71.85	71.25	71.42
TiO_2	0.17	0.28	0.16	0.23	0.15	0.19	0.11	0.22	0.15
Al_2O_3	12.95	12.65	13.01	12.91	12.30	13.01	12.65	12.91	12.85
Fe_2O	3.18	3.98	3.61	3.68	4.08	3.81	3.60	3.96	4.01
FeO	0.58	0.41	0.42	0.38	0.58	0.48	0.39	0.28	0.43
MnO	0.72	0.48	0.41	0.49	0.38	0.33	0.42	0.31	0.23
MgO	1.10	0.88	0.68	0.72	0.68	0.80	0.68	0.82	0.66
CaO	0.84	1.41	1.12	1.18	1.12	1.40	1.24	1.31	1.08
Na_2O	4.10	4.30	4.39	3.91	3.93	3.80	3.89	3.76	3.61
K_2O	4.36	4.47	4.31	4.41	4.16	4.10	4.24	4.05	4.01
P_2O_5	0.29	0.16	0.17	0.19	0.12	0.15	0.11	0.14	0.23
L.O.I	0.99	0.82	0.73	0.87	0.81	0.93	0.79	0.98	0.99
Total	100.0	100.6	100.11	99.85	100.22	100.30	99.97	99.97	99.87
Qz	27.76	25.28	26.50	28.39	29.88	29.79	29.98	30.44	31.49
Or	26.13	26.60	25.77	26.45	25.04	24.50	25.39	24.43	24.24
Ab	35.00	36.44	37.37	33.42	33.69	32.35	33.16	32.13	32.60
An	2.53	2.56	3.09	4.72	3.70	6.26	4.60	5.70	3.97
Di	0.00	2.86	1.28	0.13	1.06	0.00	0.89	0.00	0.00
Hy	2.76	0.88	1.12	1.75	1.22	2.00	1.30	2.06	1.66
Cor	0.58	0.00	0.00	0.00	0.00	0.06	0.00	0.28	0.81
Mt	3.76	2.08	2.24	2.18	2.71	2.09	2.33	1.29	1.72
Hm	0.61	2.56	2.09	2.22	2.27	2.40	2.03	3.11	2.88
Il	0.32	0.53	0.30	0.44	0.29	0.36	0.21	0.42	0.29
Ap	0.72	0.39	0.42	0.47	0.30	0.37	0.27	0.34	0.56
Zr	336	365	410	349	356	257	414	1084	1168
Y	27	33	30	28	25	20	25	34	31
Sr	187	219	225	177	177	168	218	27	62
Rb	150	165	155	130	145	117	117	83	87
Nb	16	10	20	26	20	19	23	27	39
Ba	684	709	661	636	655	735	695	170	181
Cu	10	10	11	10	10	10	11	11	11
Ni	60	37	34	35	38	44	45	50	42
Co	4	4	4	3	4	4	4	5	5
Cr	92	46	37	37	47	40	65	63	65
V	7	5	6	5	7	6	6	5	5
Zn	36	42	72	46	39	38	42	144	121
Ga	20	19	19	24	15	10	16	24	24
Pb	15	18	14	17	17	13	13	7	10
U	8.4	11.4	20.7	12.1	10.9	8.1	10.3	9.4	9.8
Th	14.0	22.9	26.9	21.5	19.2	17.7	20.2	20.5	29.2
Th/U	1.67	2.01	1.30	1.78	1.76	2.19	1.96	2.18	2.98
D.I.	88.82	88.25	89.56	88.19	88.45	86.57	88.47	86.78	88.09

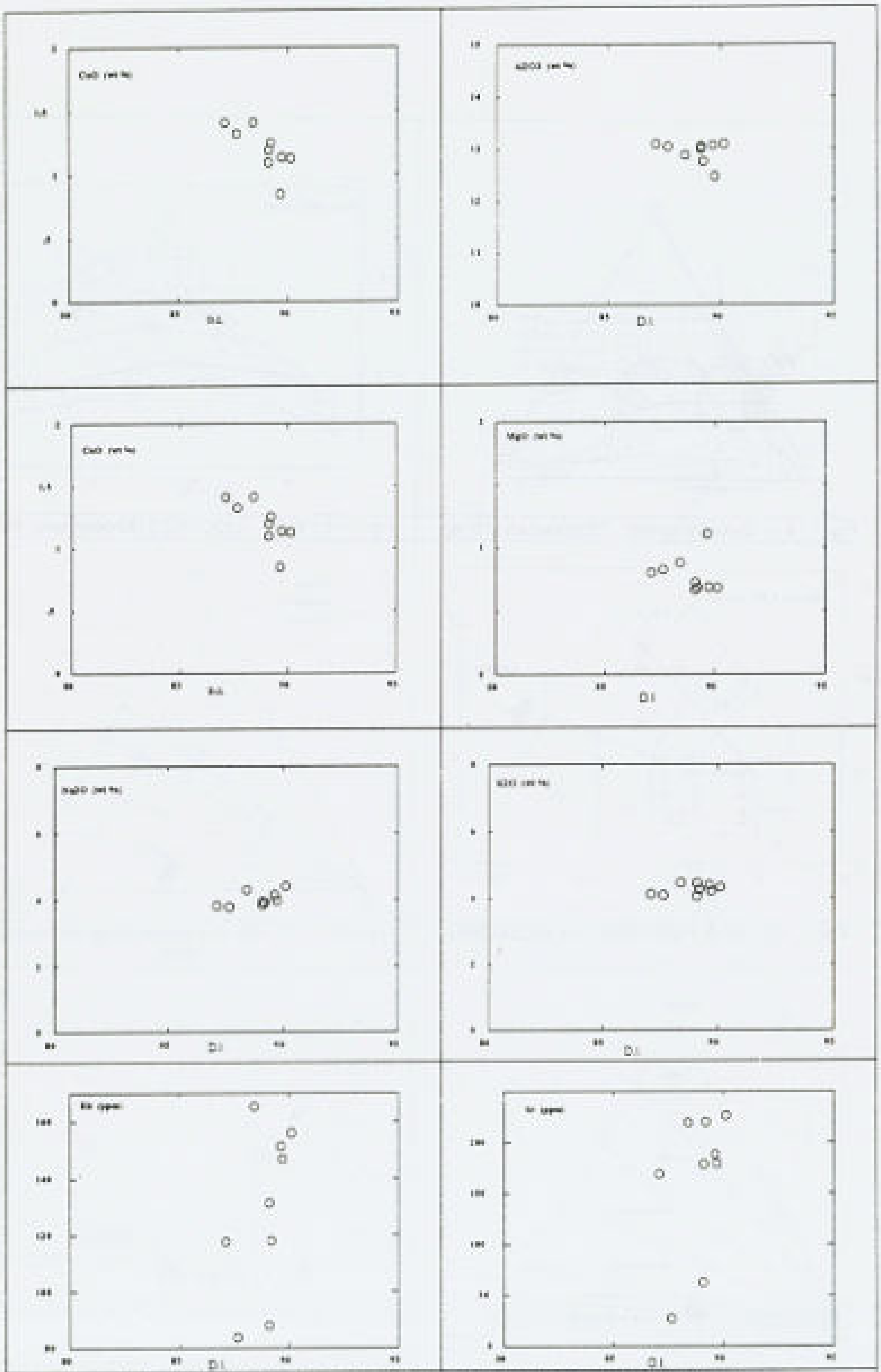

Fig. (14): Variation diagram of D.I. with major and some trace elements

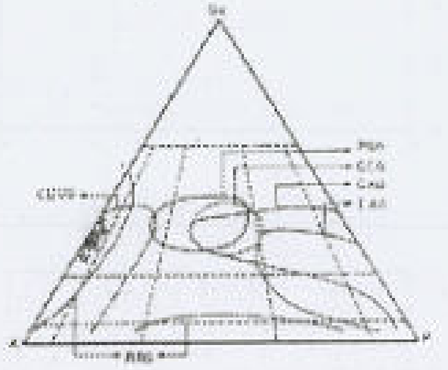

Fig. (13) : Q-A-P diagram. Streckeisen (1976)

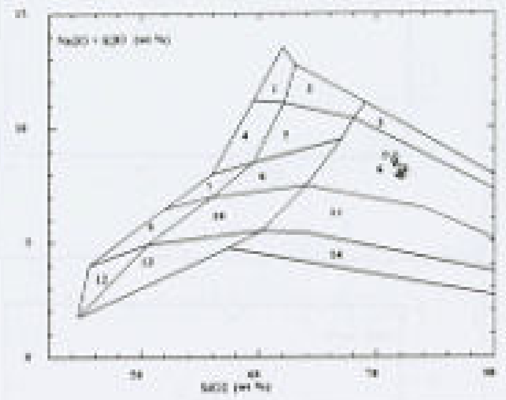

Fig. (15): SiO2- Na2O+K2O (Middlemost 1985)

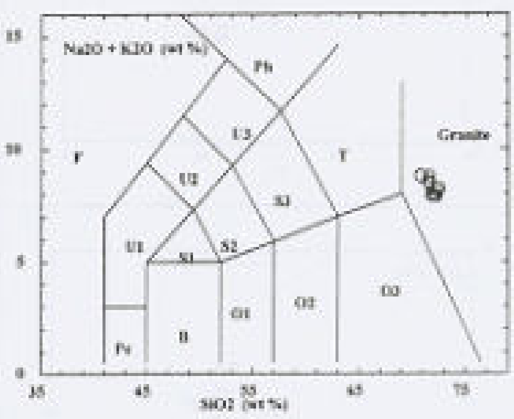

Fig. (16): SiO2- Na2O+K2O (Le Maitre1989)

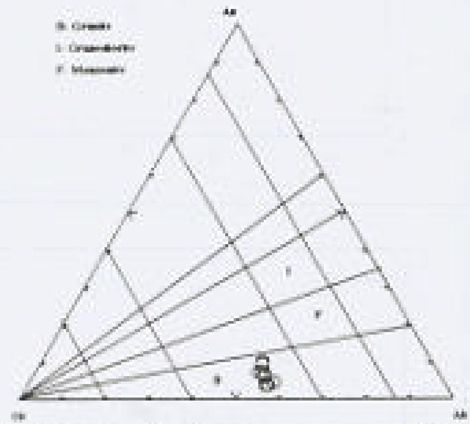

Fig. (17) : Or -Ab- An ternary diagram Hietanen, (1963)

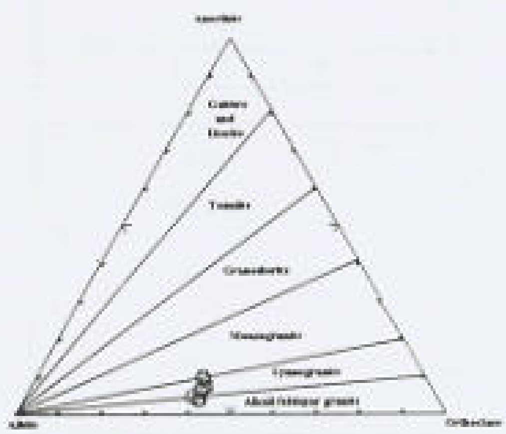

Fig. (18) : Ab-An-Or ternary diagram . Streckeisen (1976)

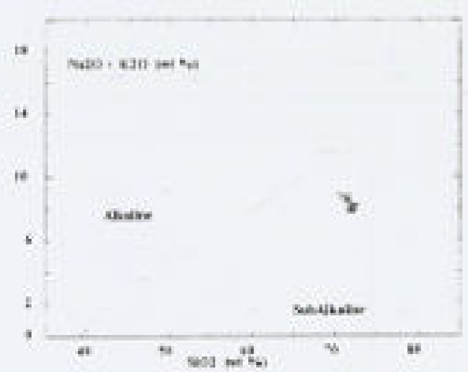

Fig (19): Na2O+K2O against SiO2. Irvineand Baragar, (1971)

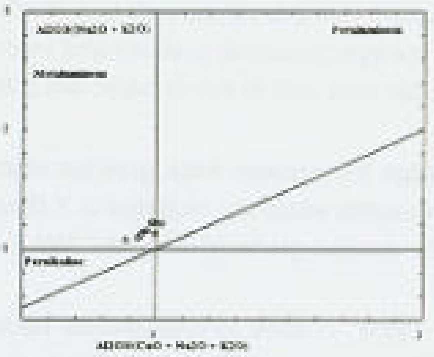

Fig. (20):Shand index (Maniar and Piccoli 1989).

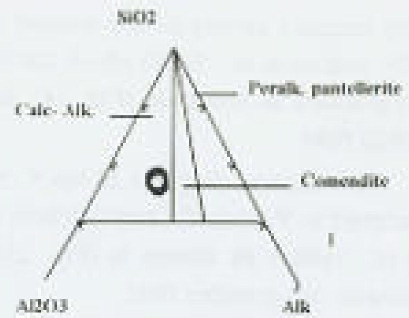

Fig. (21): SiO2-Al2O3-Na2O+K2O ternary diagram

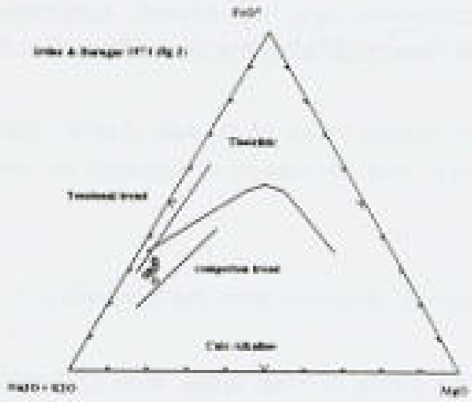

Fig. (22) : AFM variation diagram .

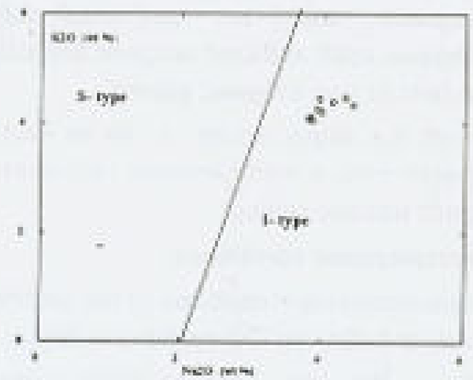

Fig. (23): Na2O-K2O (Chappal and White 1974)

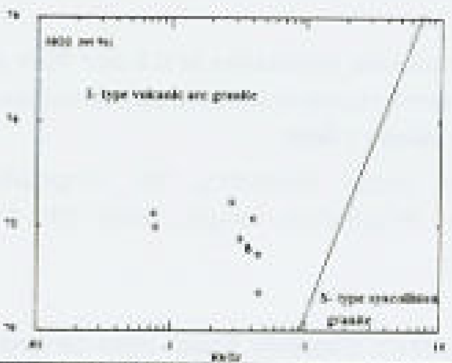

Fig. (24): SiO2-Rb/Zr (Harris et al., (1986)

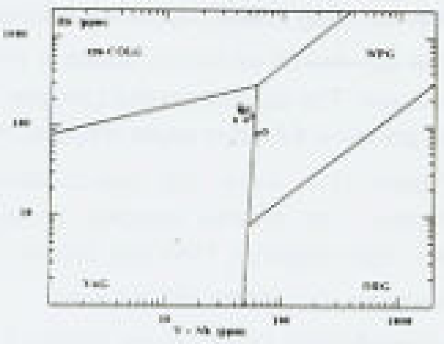

Fig. (25) : Nb-Y (Pearce et al., (1984)

4- Tectonic Setting

The tectonic setting of the studied granite is determined using bivariante plot of Rb/Zr vs. SiO_2 (Harris et al., 1984) which discriminate between the syn-collisional granites and volcanic arc granites as shown in (Fig. 24), where the studied samples plot in the volcanic arc granite (VAG) field.

The variation diagram of Nb-Y discriminates between the oceanic ridge granites which is enriched in Y contents and volcanic arc and collision granites which are depleted in Y (Pearce *et al.*, 1984) as shown in (Fig. 25). The data of the studied granitoid samples plot in the volcanic arc granites field.

The variation diagram Rb-Y+ Nb (Pearce *et al.*, 1984) is used to discriminate between volcanic arc granites depleted in Rb contents and collision granites enriched in Rb as shown in (Fig. 26). The diagram shows that the granitoid of G. Abu Aqarib plot in the volcanic arc granites field.

To discriminate between the different tectonic setting, Maniar and Piccoli (1989) used the relation between K_2O versus SiO_2 and Al_2O_3 versus SiO_2 to differentiate between oceanic plagiogranite, island arc, continental collision, continental arc, rift related, continental epeirogenic uplift and post orogenic granitoids. From figures (27&28) the studied granites lie in the field of post orogenic granite.

From the above results, it can be said, that the granite rocks of G. Abu Aqarib were originated from a metaluminous calc-alkaline magmas that developed in volcanic arc post orogenic tectonic setting.

5-Crystallization conditions

The environmental conditions of the granite rocks can be deduced from the normative (Or–Ab–An) and (Qz–Ab–Or) systems as follow.

Figure (29) shows the Ab-An-Or system with the fields of rock types after O'Connor, (1965) and Barker, (1979). The effect of PH2O on the position of cotectic boundary between orthoclase and plagioclase at 1 Kb and 5Kb PH_2O are also shown after Tuttle and Bowen (1958). The G. Abu Aqarib samples plot in the granite field and the magma was generated at somewhat intermediate depths equivalent to 4-6 Kb.

The Qz–Ab–Or system is shown in (Fig. 30). The cotectic boundaries at 0.5 and 10kb are also shown. The studied granite samples are plotted in the region which indicates formation at water pressure 4-6 kb at depth range from (9-20 km) Wilson (1989).

Figure (31) show the quartz–albite-orthoclase system illustrating the temperature isotherms. The studied samples crystallized under temperature ranging from 760°-840° (James and Hamilton, 1969 and Winkler *et al.*, 1975).

6-Petrogenesis of Granitoid Rocks

The identification of the source regions from which granitic magmatic liquids were derived as well as the nature of these magmatic liquids can be recognized from the variation patterns and inter-relationships between some elements such as K, Rb, and Ba because their behavior in these systems is strongly tied to the major minerals, e.g., plagioclase, K-feldspars, biotite and muscovite.

The K-Rb variation diagram of the studied granitoid rocks is shown in (Fig. 32). The average values of studied granite are lower than that of the crustal average value of 250 (Taylor, 1965). The higher K/Rb ratio indicates sources regions for magma generation in the lower crust (Heier, 1973) or upper mantle (Gast, 1965). Also, the higher K/Rb ratios for the more fractionated granitic phase probably indicate magma generation mechanism involving dehydration of amphiboles at deeper levels in the lower crust (Griffin and Murthy, 1969).

The K-Ba variation diagram is shown in (Fig. 33). The valus of K/Ba is less than the average crustal ratios line (K/Ba=65) which indicate that they are enriched in Ba.

The Ba-Rb variation diagram (Fig.34) can be used to signify the degree of fractionation of granite rocks. The line representing the average Ba/Rb ratio for the crust is about (4.4) (Mason, 1966). The Ba/Rb ratios of the studied granite show that they have high values than the average crustal ratio that is consistent with the suggestion that these samples originated from an enriched Ba source.

It is clear that the granitic rocks of G. Abu Aqarib area are generated at depth of about 9-20 km equivalent to 4-6 Kb and temperature ranging from 760°c to 840°c with multi-processes of both assimilation and fractional crystallization involving plagioclases, hornblende and Fe-Ti oxides from a partial melted lithospheric magma.

7- Geochemistry of U and Th.

Uranium and thorium contents were determined chemically for 9 samples of G. Abu Aqarib. The obtained results of the uranium and thorium analyses are indicated by ppm as well as Th/U are shown in Table (1).The Uranium content of G. Abu Aqarib range from 8.4to 20.7 ppm with an average 11.2 ppm while thorium ranges from 14 to 29.2 ppm with an average 21.3ppm., which is coincided with the average U of the granitic rocks of Clark et al.(1966), and also introduce in the range of the acidic intrusive rocks of Adams et al.(1959) and the silicic intrusive rocks of Rogers and Adams(1967).

The geochemical behaviour of U and Th in the studied areas can be examined as follows:

The U-Th variation diagrams for the studied rocks indicate strong positive relations between the two elements due to magmatic origin as shown in (Fig. 35). This reflects the enrichement with magmatic differentiation.

Fig. (36) shows the variation of Th/U ratios versus U in the studied rocks . It is clear from the figure that the decreasing of Th/U ratios is accompanied with enrichment in U. From the above and from figure (37) it is clear that the U and Th contents in the studied area are associated with hematitization and silicification. Also, the radioactivity is controlled by the presence of higher content of zircon as accessory minerals and iron oxides whereas iron oxide and hydroxides are know to absorb U from circulating fluids.

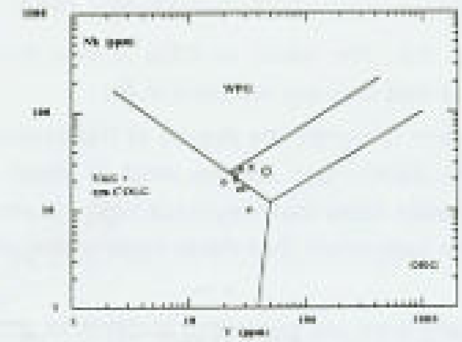

Fig. (26) : Rb-Y+Nb (Pearce et al., (1984) .

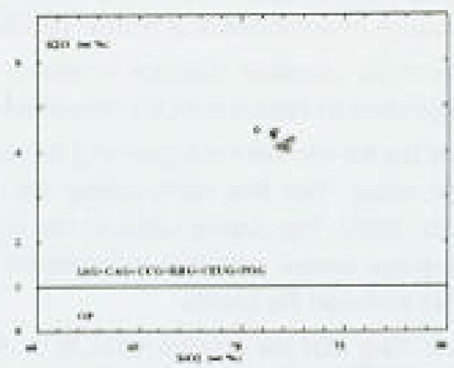

Fig. (27) : SiO2-K2O (Maniar and Piccoli 1989).

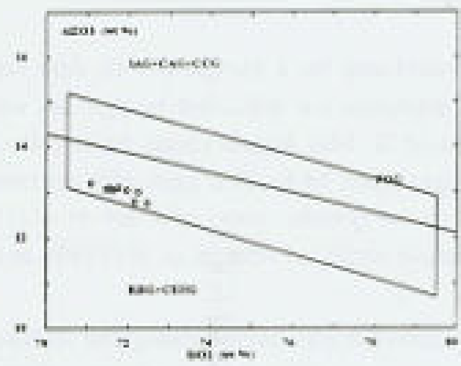

Fig. (28) : SiO_2-Al_2O_3 (Maniar and Piccoli 1989).

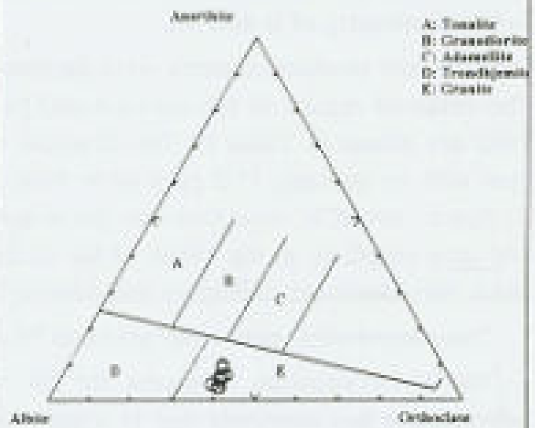

Fig. (29) : An-Ab-Or ternary diagram .

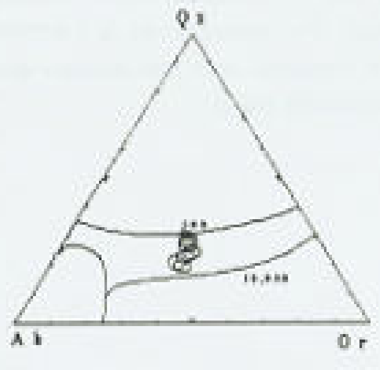

Fig. (30): Qz- Or -Ab ternary diagram.

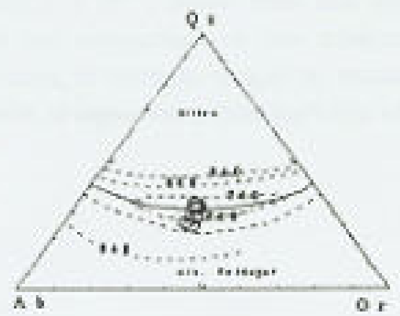

Fig. (31): Qz- Or -Ab ternary diagram.

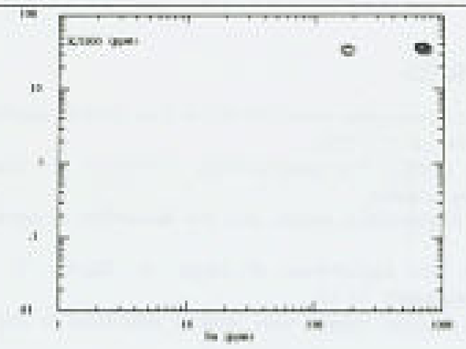

Fig. (32): K-Ba variation diagram.

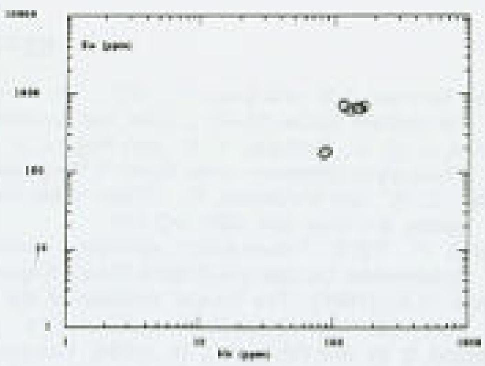

Fig. (33): Ba-Rb variation diagram.

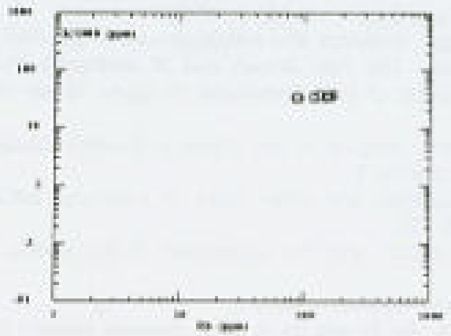

Fig. (34): K-Rb variation diagram.

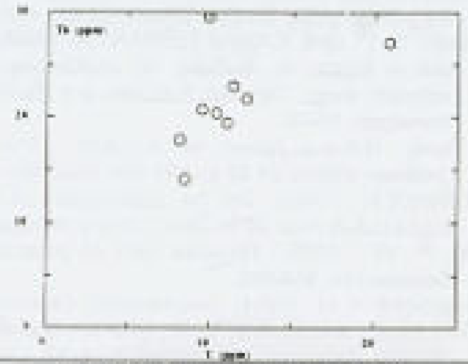

Fig. (35): Th-U variation diagram.

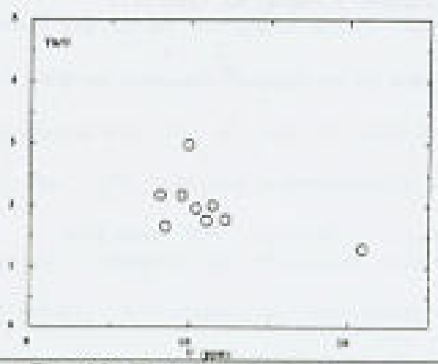

Fig. (36): Th/U-U variation diagram.

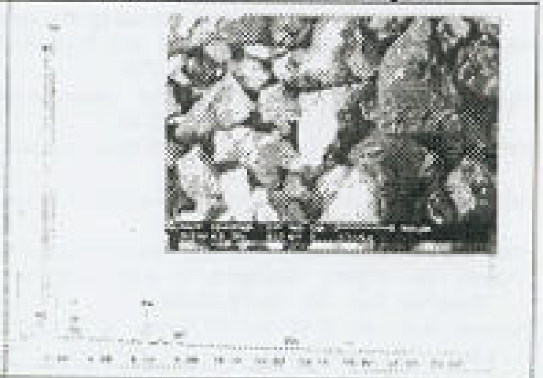

Fig. (37): EDX for Zircon

REFERENCES

Abdel Rahman, A.M. and Doig, R. (1987): The Rb-Sr geochronological evolution of the Ras Gharib segment of the northern Nubian Shield. J. Geol. Soc. London, vol. 144, p. 577-586.

Adams, J. A. S., Osmond, Y. K., and Rogers, J. J. W., (1959): The geochemistry of thorium and uranium. Physics and Chemistry of the Earth, 3, Pergamon Press, London.

Bailey, D. K., and McDonald, R., (1969): Alkali feldspar fractionation trends and the derivation of peralkaline liquids, Am. Jour. Sci., 267, 242-248.

Barker, F., 1979: Trondhjemite: definition, environment and hypotheses of origin. In: Barker, F. (ed.), trondhjemite, Dacites and Related Rocks. Elsevier, Amsterdam, 1– 12.

Bentor, Y.K. (1985): The crustal evolution of the Arabo Nubian massif with special reference to the Sinai Peninsula. Precambrian Res., vol. 28, p. 1-74.

Chappell, B. W. and White, A. J. R., (1974): Two contrasting granite types. Pacific Geol., 8, 173-174.

Clark, S. P., Jr., Peterman, Z. E., and Heier, K. S., (1966): Abundance of uranium, thorium and potassium. In: Clarke, S. P. Jr., (ed.), Handbook of Physical Constants, Geol. Soc. Am. Mem. 97, 521-541.

El-Gaby, S. and Habib, M.S. (1982): Geology of the area southwest of Port Safaga with special emphasis on the granitic rocks, Eastern Desert, Egypt. Ann. Geol. Surv. Egypt., vol. 12, p. 47-71.

El-Gaby, S. L, Lists F.K.and TEHRANY,R. (1988): Geology , evolution and metallogenesis of the Pan African belt in Egypt, In: El-Gaby, S. andGreiling, R.O.(eds). The Pan African belt of northeast Africa and adjacent areas; Tectonic Evolution and Economic Aspects of Late Proterozoic Orogeny, Braun /Schweig (viewegel), 17-70.

El Ramly, M.F.and Akaad, M. K.(1960) : The basement complex in the Centeral Eastern Desert,Egypt ,between latitude 24 30 and 25 40N.Geol.Surv.Egypt, paper No.8 .

El-Shazly,E.M. (1964) :On the classification of the Precamrian and other rocks of magmatic affiliation in Egypt,U.A.R.Proc.24 Int.Geol. Congrs. India,part x,p.88-101 .

Gast, P. W., (1965) :Terrestial ratio of potassium to rubdium and the compostion of the Earths mantle, Science,147, 858-860.

Goldschmidt, V. M., (1954): Geochemistry, Oxford Univ. Press, Oxford, England.

Griffin, W. L., and Murthy, V. R., (1969): Distribution of K, Rb Sr and Ba in some minerals relevant to basalt genesis. Geochem. Cosmochim. Acta, 33, 1389-1414.

Gunther, J. Kleman and Twist, D. (1989): The compositionally zoned sheet-like granite pluton of Bushveld complex: Evedance bearing on the nature of A-type magmatism. J. Petrol., 30, 1383-1414.

Harris, N. B. W., Hawkesworth, C. J. and Ries, A. C. (1984): Crustal evolution in the NE and E Africa from model Nd ages. Nature, 390, 773-776.

Hashad, A.H. (1980): Present status of geochronological data on the Egyptian basement complex. Inst. App. Geol. Bull., (Jeddah), vol. 3, p. 31-46.

Hassan, M. A. and Hashad, A. H. (1990): Precambrian of Egypt. In: Said, R. (ed.). The geology of Egypt. Balkema, Rotterdam, p. 201-245.

Heier, K. S., (1973): Geochemistry of granulite facies rocks and problems of their origin. Phil. Trans Roy. Soc. Lond.., A 273, 429-442.

Hietanen, A., (1963): Idabo Batholith near Pierce and Bungalow. U.S. Geol. Surv., Prof. Paper 334p.

Hildreth, W. (1981): Gradients in silicic magma chambers: Implications for lithosphere magmatism. J. Geophys. Res., 86: 10153-10192.

Hussein, A.A., Ali, M.M. and El Ramly, M.F.(1982): A proposed new classification of the granites of Egypt. Jour. Volc. Geoth. Res., vol.14, p. 187-198.

Irvine, I. N. and Baragar, W. R. A., (1971): A guide to the chemical classification of common volcanic rocks, Can. Jour. Earth Sci., 81, 523-548.

James, R. S. and Hamilton, D. L. (1969): Phase relations in the system NaAlSi3O8-KAlSi3O8-CaAl2SiO8-SiO2 at 1 kilobar water vapour pressure. Contrib. Mineral. Petrol., 21, 111-141.

Khalaf , I.M. , Abdel Monem, A.A. ,Attawiya, M.Y. , Ammar,S.E., and El-Sawey,E.H. (2000) : Petrology ,geochemistry and radioactivity of Abu Aqarib alkaline granite, Central Eastern Desert , Egypt. Annals Geol.Surv.,Egypt,V.23(2000),pp.261-274.

Le Maitre, R. W. (1989): A classification of igneous rocks and glossary of terms recommendation of the international Union of Geological Sciences Subcommission on the Systematics of Igneous Rocks. Blackwell Scientific Publications, London: 193p.

Maniar, P. D., and Piccoli, P. M., (1989): Tectonic discrimination of granitoids. Geol. Soc. Am. Bull., 101, 635-643.

Mason, B., 1966: Principles of Geochemistry, 3rd Ed., John Wiley and Sons Inc., New York, 329.

Middlemost, E. A. K., (1985): Magmas and magmatic rocks. Longman, London.

O'Connor, J. T., (1965): A classification of quartz-rich igneous rocks based on feldspar ratios, U.S. Geol. Surv., Prof. Pap. 525B, B79-B84.

Pearce, J. A., Harris, N. B. W. and Tindle, A. G. (1984): Trace element discrimination diagrams for the tectonic interpretation of granitic rocks. Jour. Petrol., 25, 956-983.

Petro, W. L., Vogel, T. A. and Wilband, J. T. (1979): Major element geochemistry of plutoniv rock suites from compressional and extensional plate boundaries. Chem. Geol., V.26, P. 217-235.

Pitcher, W. S. (1983): Granite: Topography, geological environment and melting relationships. In: Atherton M. P. and Grippels C. D. (eds.) Migmatites, melting and metamorphism. Shiva Pub. Ltd., Cheshire, UK, 277-285.

Ressetar .R. and Monrad .J.R.(1983): Chemical composition and tectonic setting of Dokhan volcanics formation, Eastern Desert, Egypt A; journal of African Earth Science.

Rogers, J. J. W., and Adams, J. A. S., (1969): Uranium and throium. In: (ed. K.H. Wedepohl) Handbook of Geochemistry, II-3, 92-B-1 to 92-0-8 and 90-B-1 to 90-0-5 In. Springer Verlag.

Stem, R.J. and Hedge, C.E. (1985): Geochronologic and isotopic constraints on late Precambrian crustal evolution in the Eastern Desert of Egypt. Am. J. Sci., vol.258, p. 97-127.

Stem, R.J., Gottfried, D.G. and Hedge, C.E. (1984): Late Precambrian rifting and crustal evolution in the North Eastern Desert of Egypt. Geology, vol.12, p. 168-172.

Streckeisen, A. L. (1976): Classification of the common igneous rocks by means of their chemical compositions. A provisional Attempt. N. Jb. Min. Jour., 1-15.

Taylor, S. R. (1965): The application of trace element data to problems in petrology. In:Physical and Chemistry of the Earth (ed.); Ahrens, L. H., Press. F., Runcor, S. K. and Urey, H. C., 133-213.

Tuttle, O. F. and Bowen, N. L., (1958): Origin of granite in the light of experimental studies in the system NaAlSi3O8-KAlSi3O8-SiO2-H2O. Geol. Soc. Am. Mem., 74, 153p.

Wilson, M. (1988) : Igneous Petrogenesis : Unwin Hyman, London, 466p.

Winkler, H. G. F., Boese, M., and Macropoulos, T., (1975): Low temperature granitic melts. N. Jb. Mineral., 6, 245-262.

بتروكيميائية واشعاعية صخور جرانيت الفلسبار القلوي بمنطقة جبل أبو عقارب وسط الصحراء الشرقية- مصر

عطا عبد الشافي - وفقي السيد النجار

هيئة المواد النووية

يتناول هذا البحث دراسة جيولوجية و جيوكيميائية و اشعاعية صخور جرانيت الفلسبار القلوي بمنطقة جبل أبو عقارب وسط الصحراء الشرقية- مصر. والتي تغطي مساحة ١٣٦ كم٢ تقريبا . جيوكيميائيا ومن خلال التحاليل الكيميائية للعناصر الأساسية والشحيحة وعنصري اليورانيوم والثوريوم ثبت أن هذا الجرانيت نشأ من نوع I من مجما كلس قلوية فوق الومنية في بيئة قوس بركاني تحت ضغط من ٤-٦ كيلو بار ضغط مائي على عمق ٩-٢٠ كم وفي درجة حرارة من ٧٦٠-٨٤٠ م بعمليات التمايز البلوري . كما ثبت أيضا أن تركيز اليورانيوم والثوريوم مرتبط بالعمليات المجماتية ويتواجد مع معادن الزركون والأباتيت وأكاسيد الحديد.